# EVALUATION OF RISK FACTORS INFLUENCING SURGICAL OUTCOME IN MENINGIOMAS WITH "CLASS" ALGORITHM

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**THE TAMILNADU DR.M.G.R. MEDICAL UNIVERSITY**

**CHENNAI TAMILNADU**

# CERTIFICATE

This is to certify that this dissertation entitled "***EVALUATION OF RISK FACTORS INFLUENCING SURGICAL OUTCOME IN MENINGIOMAS WITH "CLASS" ALGORITHM***" submitted by **Dr.G.M.Niban** to the faculty of Neurosurgery, The Tamil Nadu Dr. M.G.R. Medical University, Chennai, in partial fulfilment of the requirement in the award of degree of **MASTER OF CHIRURGIE IN NEURO SURGERY**, **Branch – II**, for the **August 2013** examination is a bonafide research work carried out by him under our direct supervision and guidance.

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# DECLARATION

I, **Dr.G.M.NIBAN** solemnly declare that the dissertation titled "**EVALUATION OF RISK FACTORS INFLUENCING SURGICAL OUTCOME IN MENINGIOMAS WITH "CLASS" ALGORITHM**" has been prepared by me under supervision of Professor and HOD,Department of Neurosurgery,Madurai Medical College and Government Rajaji Hospital, Madurai between **2010** and **2013**.

This is submitted to The Tamil Nadu Dr. M.G.R. Medical University, Chennai, in partial fulfillment of the requirement for the award of **MASTER OF CHIRURGIE, M.Ch., NEUROSURGERY,** degree examination to be held in **AUGUST 2013.**

**Place : Madurai**

**Date :** **DR.G.M.NIBAN**

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# CONTENTS

# INTRODUCTION

Meningiomas are one of the most common extraaxial neoplasms of intracranial nature constituting 13-25% of all intracranial neoplasms. Recent advances in neuroimaging has increased the incidence of asymptomatic meningiomas. Arising from arachnoid cap cells meningiomas are present in varied locations and are of diverse histopathological types primarily stratified by the WHO classification into three grades with the majority being of benign grade.

Treatment options for meningiomas have varied historically from mere observation to surgery to radiation therapy to combined modalities of treatment. Most meningiomas being benign and slow growing proper planned treatment is possible thus providing higher chances of complete extirpation of these tumours.The degree of complete surgical removal essentially depends on the location of the tumour and the presence of nearby vital neurovascular structures and eloquent brain matter. The success or otherwise of the surgical modality of treatment offered rests on the completeness of resection as graded by Simpson grading which primarily correlates the degree of extirpation of the meningioma and associated dura with the probability of recurrence.

The varying and heterogenous nature of presentation of the various types of meningiomas and the commonality of occurrence has sparked efforts to primarily predict the success of surgical outcomes in meningioma surgery.In essential because of the benign histological nature of meningiomas it is imperative that proper assessment of the risk and benefit ratio of surgery for individual patients with meningiomas is done keeping with the basic tenet of benefits to far outweigh the risks involved. With this aim in mind various stratification systems like the “CLASS” algorithm have been developed the validity of which is assessed in this study.

# AIM OF THE STUDY

Aim of the study is,

1) To analyze the various epidemiological and risk factors associated with and influencing surgical outcome in the treatment of meningiomas.

2) To assess the validity of the CLASS algorithm as applied to patients diagnosed with meningiomas and subject to surgical treatment and comparing the findings and outcome of this study with other major studies in literature utilizing CLASS algorithm for meningiomas.

# REVIEW OF LITERATURE

The study of meningiomas which are the most common extracranial tumors of intracranial origin makes interesting considerations as the presentation and clinical features of meningiomas covers the whole gamut of neurosurgical spectrum considering the varied locations where these lesions are located making them truly “**ubiquitous”**” in nature.

According to epidemiological studies meningiomas form about 33.8% of all primary brain and CNS tumours[1] and are one of the most commonly diagnosed primary brain tumours. This statistical viewpoint has also been modified and challenged and tends to include incidentally diagnosed groups of meningiomas which account for those kind of tumours that are diagnosed during autopsy[2] and by incidental neuroimaging.It has also been analyzed that a 3-3.9 fold increased incidence of meningiomas[3] has been recorded in the post Computerized Tomography era.

Risk factors involved in the pathogenesis of meningiomas have been diverse in nature and range from inherited genetic polymorphisms mainly in association with NF-2.Other risk factors include environmental factors such as ionizing radiation[4] and exogenous and endogenous hormones[5]. Population statistics based on epidemiological studies indicate about 20% incidence in males and 38% in females[3].The mean ratio of occurrence varies from 1:1.4 to 2.6[6] .This observation also has an inherent ethno geographic connotation in that the overall incidence and sexual predilection is less common in Asian racial groups[7]

The consensus with regard to age related incidence of the intracranial meningiomas is that there is a marked positive correlation of increased occurrence[1] with increasing age. The peak incidence being in the mean age of 56.4 in males and 55.9 in females. The highest percentage of tumour occurrence is in the age group of 40-59 (37%) and 60-79 (38%) respectively.

Pathophysiologic analysis with respect to the site of occurrence reveals no specific predilection with respect to side, the right side involved in 44% of lesions and the left in 43% of lesions.Histopathologically most of these (92%) fall into the benign category with 8% showing atypical or malignant features[8].Based on histologic features the meningothelial type is the most common about 63% of tumors, the second most common is the transitional type (19%) closely followed by fibrous type (13%) and the psammomatous type (2%). Based on the microscopic findings of degree of mitoses and cellular changes of increased cellularity,small cell formation, prominent nucleoli, sheet like and areas of spontaneous growth, meningiomas can be divided into atypical (4 or more mitoses/10 HPF) types like chordoid and clear cell and anaplastic (20/10 HPF),rhabdoid and papillary types the latter being the more aggressive associated with grave implications on morbidity and mortality of affected kindreds[9].

With regard to the site of occurrence of meningiomas parasagittal and falcine (25%),convexity lesions (19%),sphenoid ridge 17%, followed by suprasellar 9%, posterior fossa 8%, olfactory groove 8%, middle fossa/Meckel's cave 4%, tentorial 3%, peri-torcular 3%, lateral ventricle 1–2%, foramen magnum 1–2%, and orbit/optic nerve sheath 1–2%.

Among the parasagittal meningiomas,49% are located over the anterior one third of the falx, with29% in the middle third, and 22% along the posterior third.Medial sphenoid ridge meningiomas were more common than middle or lateral sphenoid ridge meningiomas.

Multiple meningiomas or meningiomatosis is encountered in 2.5% of meningiomas The incidence of ectopic location is 0.4% with the majority (73%) occurring inside the orbit, paranasal sinuses, eyelids, parotid gland, temporalis muscle, temporal bone, and zygoma. Distant sites have also been reported, such as the lungs, mediastinum, and the adrenal glands[10].

The histological nature also has some correlation with the site of occurrence in that lesions located in the midline of the skull base are meningothelial in nature as demonstrated by Lee et al[11].

The malignant and atypical type of meningiomas are located primarily in the supratentorial compartment (73-75%)[12] primarily over the cerebral convexities with the ratio of calvarial to skull base lesions being 2.3: 1[13].

Environmental causes of risk factors associated with meningiomas include ionizing radiation with a six to ten fold increased risk. Therapies used for treatment of Tinea Capitis in children and for intracranial tumours and investigative modalities like dental radiographs and CT scans have also been traditionally associated with increase in odds ratio[14] of occurrence of meningiomas.

The increased and widespread use of cellular mobile phones has prompted intensive debate regarding the risks of increased incidence related to cell phone use related to occurrence of meningiomas. The primary pathophysiologic factor implicated was the microwaves with most studies indicating no correlation[16] though some indication related to increased occurrence of gliomas being demonstrated in some studies[15].

The tumorigenesis of meningiomas in female patients has been a subject matter of interest in that increased risk of occurrence with positive correlation has been shown with hormonal replacement therapy especially with long acting therapies like dermal implants and hormonal IUDs[17].

OCP use though has not shown any characteristics of increased occurrence. Therapeutic intervention in the form of anti-hormonal therapy has not been proven to be efficacious in the overall treatment of meningiomas[18].

Trauma has been purported to play an important role in the evolution of meningiomas since the time of Cushing and Eisenhardt, more in the male population with a reported lag period of about 10 -19 years[19]. But recent studies have negated the possibility as is shown by the Mayo Clinic analysis of meningiomas showing no special predilection due to trauma[20].

The implication of viruses in the etiopathogenesis of meningiomas has been inconclusive[21] with recent investigative modalities like PCR and IHC showing no relation to SV40 Tag,JC virus or BK virus infection.The detection of viral DNA, RNA or antigens has been attributed to either latent infection or contamination[22].

The natural history of meningiomas reveals the benign and slow growing nature of these tumours. It has been shown that about 3% of adults above 60 harbour asymptomatic meningiomas.[23]

Volumetric analysis of meningiomas which are asymptomatic have shown a growth rate of about 4mm/year.Studies have revealed that serial imaging modalities show that the annual growth rate of asymptomatic meningiomas of less than 1cm$^3$ m/year have been recorded in 66% of such patients and the tumour doubling time was about 21.6 years.[24]However the exact epidemiology has been difficult to quantify because of the variation in clinicoradiological assessment of exact tumour growth.

The general consensus is that tumours detected in younger age group of patients possess an inherent faster and accelerated tumour growth compared to similar lesions in the elderly especially patients over the age of 60.

Tumoural biology of meningiomas also has a heavy bearing on the progression of these lesions. Characteristics like excessive calcification as evidenced by hypointensity in MRI imaging studies, the initial size and volume of the tumour at time of presentation and the site of location of these lesions play an important and significant role in the assessment of natural growth pattern of meningiomas.[25]

With regard to the location of meningiomas the lesions that occupy the skull base especially the region around the cavernous sinus, clinoidal processes and petroclival region have been shown to demonstrate slow or indolent type of growth despite alarming nature of presentation in imaging studies. Such tumours because of their inherent lack of progression and growth also demonstrate only limited clinical and neurological deterioration mostly spread over a long period of time.[26] The counter argument in the treatment of skull base lesions is that their infratentorial location coupled with the irregularity in shape makes it less amenable to exact volumetric assessment and hence patients with small and medium sized lesions with a higher propensity of growth should be subjected to early surgical treatment depending on the individual assessment of the risk benefit ratio pertinent to each patient.[26]

The progression of tumours also depends on the histologic grade of meningiomas based on the WHO classification with the tumour doubling time ranging from 415+ days for grade I tumours to 205+ days for grade III tumours with definite indicators of significant difference between grade I and grade II/III tumours[27]. The tumour doubling time has also been linked to the variation in cellular proliferative and divisional capabilities of individual cells as evaluated and stratified by the mitotic index,labelling indices like MIB/Ki-67/BUdR.[28]

Imaging modalities play an important role in the evaluation,assessment,stratification,risk analysis, surgical planning,treatment protocol, risk-benefit ratio appraisal and recurrence probability of meningiomas.The use of CT characteristics and MRI evaluation form the basis of localization of the various types of meningiomas.The classical finding in MRI is the enhancement on T1W contrast imaging and the hyperintensity in T2W imaging with variations depending on the histologic characteristics.Adjunctive treatment protocols like MRS, Octreotide scintigraphy, PET scanning, SPECT scanning.[29]

The role of preoperative angiography is paramount with the features of the blush and the marginal sunburst appearances providing more than adequate detail regarding the source of the blood supply thus helping in prediction of adequacy of surgery and also to assess the need for preoperative embolization and also help in devascularisation and efficient extirpation of meningiomas.[30]

Depending on the localization of the lesions the symptomatology of tumours differs with headache and seizures forming the bulk of presentation characteristics.The varied spectrum of presentation with regard to the neurological deficits mirrors the functional organisation of the nervous system. The neurological deficits are also influenced by the degree of encasement and displacement of vital vascular and neurological structures.

The benign and slow growing nature of majority of meningiomas entails various management options which include observation, surgical options, radiation both as an adjunct and as primary therapy. The measure of success of outcome is primarily measured by the degree of clinical improvement as assessed by various scales and scores such as Glasgow outcome scoring and the Karnofsky Performance Scale (KPS).

The type of meningioma and location of the lesion and the degree of neurological involvement and patient characteristics such as age, presence of comorbidities and the location and grade of possibility of resection as is evaluated by the various investigative modalities provides an adequate roadmap for the type of management that is contemplated.

Observation with periodic followup and neuroradiological imaging is one of the modalities of treatment preferred primarily in patients with certain type of skull base meningiomas which are asymptomatic or present with minimal symptoms, patients who present with incidental tumours with very little oedema, and those group of patients who chose non-surgical modes of therapy but in all these conditions the primary emphasis is on the willingness and essentiality of both clinical and radiological followup.The location of tumours and the degree of extirpation and resection that is adequately possible as judged by clinicoradiological correlation also dictates advocacy of observation taking into account the risk benefit ratio of surgical methodologies.[31]

The evolution of surgical management of meningiomas entails interesting study in that it mirrors the development of neurosurgery.The earliest recorded surgical extirpation was performed by Laurence Heister in 1743 in Helmstad, Germany.The surgical removal of dural based tumours was primarily described by Italian neurosurgeon Andrea Berlingheiri in 1813.The first successful removal of intracranial meningioma was done by Zanobi Pecchioli in Siena in 1835[32]. Sir William Macewen described the index successful removal of an olfactory groove meningioma in 1849[33] and the first success in the United States was by William Keen in 1887.

The thorough documentation and description of the various facets of meningiomas was first done by Herbert Olivecrona but the most exhaustive and all-encompassing work on meningiomas was done by none other than Harvey Cushing who along with Louise Eisenhardt produced the voluminous treatise on meningiomas and the associated features and surgical management with special emphasis on outcome and end results.[34]

The advancement in techniques and instrumentation technology has influenced both the type of surgical treatment and refined the method of resection being done and has helped definitely to reduce the degree of recurrence thus helping in both improving the overall surgical outcome and improving the quality of life of patients afflicted with this pathology.

About 92% of meningiomas are treated by surgical methodologies and this is dictated by the area of location of the lesion. The intended goals of therapy are to primarily resect the tumour along with the involved dura and adjoining bone.This is to a large extent influenced by the degree of hyperostosis and bony involvement that is inherently present during presentation.[35]

The second goal of surgery is to reverse or aim to ameliorate the neurological deficits and strive to improve the morbidity of the patient.

Other anciliary surgical goals in difficult to access tumoursa is the aim of obtaining samples for tissue diagnosis and debulking of the lesion in order to make it more amenable for radiosurgery.

The improvement in radiotherapeutic modalities and the advent of better delivery methods for radiosurgery has influenced the extent of radicality and has tilted the scale towards lower risk to benefit ratios with the remnant tumour mass being dealt with radiosurgical alternatives.

The success of surgical therapetics has traditionally been measured by the Simpson grading.The basic tenets of surgery[36] in meningiomas are :

1) Optimal positioning, incision and exposure

2) Early tumour devascularization

3) Intratumoural debulking and extracapsular dissection

4) Early localization and protection of neurovascular structures

5) Adequate removal of bone and dura.

The adequacy of resection was propounded by the five stage classification system as devised by Simpson in 1957[37].It essentially helped to predict the degree of expected recurrence with grade I resections having a 10% recurrence with a progressive increase in recurrence in the higher grades of resection.

The microsurgical perspective was introduced into the Simpson system by Kobayashi et al in 1992 with the microscopic resection being incorporated into the Simpson classification.

| GRADE | DESCRIPTION |
|---|---|
| 0 | Macroscopically complete tumor removal with excision of the tumors dural attachment and any abnormal bone with margin of 2cm. |
| I | Macroscopically complete tumor removal with excision of the tumors dural attachment and any abnormal bone |
| II | Macroscopically complete tumor removal with coagulation of its dural attachment |
| III | Macroscopically complete removal of the intradural tumor without resection or coagulation of its dural attachment or extradural extensions |
| IV | Subtotal removal of the tumor |
| V | Simple decompresssion of the tumor |

**Modified Shinshu Grade /Okudera Kobayashi Grade**

| GRADE | DESCRIPTION |
|---|---|
| I | Complete microscopic removal of tumor and dural attachment with any abnormal bone |
| II | Complete microscopic removal of tumor with diathermy coagulation of its dural attachment |
| IIIA | Complete microscopic removal of intradural and extradural tumor without resection or coagulation of its dural attachment |
| IIIB | Complete microscopic removal of intradural tumor without resection or coagulation of its dural attachment or of any extradural extensions |
| IVA | Intentional subtotal removal to preserve cranial nerves or blood vessels with complete microscopic removal of dural attachment |
| IVB | Partial removal, leaving tumor of <10% in volume |
| V | Partial removal, leaving tumor of >10% in volume, or decompression with or without biopsy |

The outcome of surgery in meningioma treatment is evaluated on the basis of various parameters these being primarily divided into

Patient related

Procedure related

Pathology related

Surgeon related

The interrelationship of these various factors determines the morbidity, mortality and the ultimate quality of life of patients with meningiomas as measured by KPS and GOS.

Comorbidity status of the individual, age ,location and size of the tumour,and the presence or absence of neurological deficit are the most important of the procedure related parameters that influence surgical outcome.

The QOL (Quality of life ) measurement is also of paramount importance as irrespective of surgical procedure related success the efficacy of the outcome depends on the functional outcome of the patient. Complications inherent to the pathology and the operative intervention are primarily divided into surgical and medical complications.

The important surgical complications are infection hemorrhage, CSF leakage, pseudomeningoceles and wound related problems. The medical complications essentially fall into deep vein thrombosis, seizures and pulmonary embolism.

The rethink in the modality of treatment suitable for each patient has been necessitated by the improvement in the efficaciousness of both radiation therapy and radio surgery protocols.

Traditionally the extent of surgical resection as stratified by the Simpson grade of resection has been used to predict the risk of recurrence with lower grades correlated with decreased probability of recurrence. Additional factors of importance include the WHO grade of tumour with higher grades like atypical and anaplastic kindreds necessitating gross total resection to reduce the incidence of recurrence as this is associated with poor prognosis and decrement in overall survival and morbidity patterns.

Proliferative markers such as MiB-1,CDKN 2A deletion have been associated with marked and intense increase in the doubling time and regrowth potential after surgical extirpation thus influencing the morbidity and progression profile of these lesions.

The site of occurence and location of the meningioma also determines the ease of approach and the potential for complete resection. Based on the location olfactory groove and planum sphenoidale meningiomas have shown a 4.9% recurrence over a 5 year period with gross total resection of 92%.[38]

Tuberculum sellae meningiomas pose difficulties in resection as they are in close proximity to vital neural and vascular structures especially the optic nerve with a recurrence rate of 2.8% in a mean follow up of 3.8 years but with a visual deterioration of 17-20%.Hence the need for close follow up as there exists a need for radiosurgery or repeat surgery.[39]

Optic nerve sheath meningiomas present an important category in the sense that the degree of morbidity dictates the treatment approach and Dutton et al have reviewed these lesions and report a 30% morbidity with a 25% recurrence and only a 5% improvement in visual symptoms with surgery specifically indicated only to prevent intracranial extension or spread of lesions.[40]

Convexity meningiomas in view of their potential to be amenable to total extirpation show only a 1.8%  recurrence with very low morbidity and mortality profiles.[41]

Parasagittal meningiomas because of their unique relationship to the SSS have been associated with a recurrence rate of 4% if SSS is not involved but about 13.9% if the SSS is encompassed.Fractionated radiotherapy is now found to be more useful in these lesions.[42]

Sphenoidal ridge meningiomas show a recurrence rate of 9-18.9% with the medial sphenoidal types showing a higher rate because of the potential involvement of the cavernoussinus and the adjoining neurovascular structures.[43]

Clinoidal meningiomas are limited by the degree of proximity to the Internal Carotid vessel and micro neurosurgery has proved effective in decreasing the recurrence potential by improving the extent of extirpation.[44]

Cavernous sinus meningiomas are associated with both an intra and extracavernous involvement and recurrence rates of about 13% have been reported but with the high incidence of morbidity and neurovascular compromise multimodality treatment with the addition of radiotherapy are reported to yield better results.[45]

Petro-clival meningiomas form one of the most complex groups of lesions as they are inherently difficult to completely resect the completeness of which depends on the intactness of the arachnoid plane,consistency of the lesion and the proximity of vital elements with recurrence rates as high as 25%.This has prompted the subtotal resection with adjuvant radiotherapy is the treatment of choice in these meningiomas. Stereotactic radiotherapy with fractionation or multisession in the case of larger tumours is also effective with adequate debulking in 92-97% of patients.[46]

In cerebellopontine angle meningiomas the primacy is preservation of the function of the VII and VIII nerve with better results possible in lesions located posterior and superior to the IAC compared to intrameatal and premeatal locales.[47]

Foramen magnum and jugular foramen meningiomas are in proximity to the brainstem and the lower cranial nerves precluding complete resection without compromise in function.[48]

Cerebellar convexity meningiomas have a recurrence rate of 14% over 19 months the incomplete resection due to the presence of the Torcula heterophili the management of which has lead to poor outcomes.[49]

Tentorial meningiomas present in a wide spectrum of varieties with complete resection rates of 77-91% with recurrence rates of 8.1% (Grade I resection only ) with a morbidity rate of 19.8% and mortality rate of 2.5% with the falcotentorial and the peritorcular being the most difficult and need extensive venous sinus reconstruction when the recurence rates demonstrated are 16-17%,the preservation techniques are associated with a 25% recurrence.[50]

Intraventricular meningiomas are associated with hydrocephalus and attendant increased morbidity the surgical resection of these are associated with a recurrence of about 8.3% when gross total resection rates are pegged at 87.5%.[51]

With this background of information the "CLASS" algorithm was proposed by Lee et al, the purpose of which was to analyze the risk benefit ratio of the surgical alternatives provided to patients with meningiomas and the study of the impact of the various preoperative risk factors on the degree of functional outcome after surgery.

The stratification of patients is based on the factors of

1) **Comorbidity**

It is assessed the use of the ASA scale with reference to the ability or otherwise of patients to withstand surgical procedures and tolerate anaesthetic medications. The scores assigned are 0 for grade I, -1 for ASA II and -2 for ASA III.ASA IV and ASA V are not included as they are not considered desirable candidates for surgery.

2) **Location:**

Tumor location was classified as

"Low-risk" locations included convexity and lateral skull base (lateral and middle sphenoid wing, posterior petrous) and were given a score of 0. Olfactory groove, planum sphenoidale, tentorial (lateral/paramedian), parasagittal, intraventricular,cerebellopontine angle, falcine,posterior/lateral foramen magnum as well as para-sigmoid and para-transverse

sinus locations constituted the “moderate risk” group and were assigned a score of -1. The “high-risk” locations included clinoidal, cavernous sinus, tuberculum sellae, tentorial (medial/incisural), ventral petrous, petroclival and anterior/anterolateral foramen magnum, for which a score of -2 was given.

**3) Age:**

A score of 0 was assigned for patients who are 60 years of age or younger, -1 for 61–70 years and -2 for 71years or older.

**4) Size:**

A score of 0 was given if the maximum tumor size was 2 cm or less, +1 for between 2.1 and 4 cm, and +2 for tumors larger than 4.1 cm.

5) Signs and symptoms:

A score of 0 was assigned for incidentaltumors and +1 for mild symptoms or irreversible neurologic deficits. A score of +2 was assigned for severe symptoms or reversible

neurologic deficits.

| Factors | Score | | | | |
|---|---|---|---|---|---|
| | -2 | -1 | 0 | 1 | 2 |
| Co-morbidity | ASA 3 | ASA 2 | ASA 1 | | |
| Location | Complex | Moderate | Simple | | |
| Age | ≥71 | 61 – 70 | ≤60 | | |
| Size | | | ≤2cm | 2.1 – 4cm | >4cm |
| Signs and Sym. | | | Asympt. | + | ++ |
| Other | | Prior RT / Sx[1] | | Progres.[2] | |

The stratification of outcome is done using the GOS and the attendant neurological, post-operative and medical complications are factored in the compartmentalization of the patients undergoing surgical treatment of meningiomas and the risk benefit ratio assessment thereof.

# MATERIALS AND METHODS

The analysis was done after proper approval from the IRB/IEC of Government Rajaji Hospital, Madurai on patients who were admitted in the Department of Neurosurgery, Government Rajaji Hospital during the period 2009-2013 and were diagnosed as having meningiomas on the basis of clinical and radiological features.

The variables studied included the age, sex and presenting symptoms of the patient with stratification of the patients with regard to their comorbidities and pre-existing medical and chronic disorders and the clinical profile and placed as per the ASA(American Society of Anaesthesiologists) grading from I to IV.

The radiological picture was recorded and the parameters studied were the cross sectional size of the lesion in its maximum extent as reported by the radiologist using standard protocol. Other parameters studied were the anatomical location of the lesion with respect to the normal anatomical disposition of the tumour and the degree of proximity to the vital neural and the vascular entities present in that area and the degree of secondary effects caused by the lesion to the internal milieu of the brain and intracranial compartments.

The inclusion criteria for the patients were categorized as those who were offered the surgical alternative and were willing for surgery as well as amenable and accessible to regular follow up.

The patients who underwent surgery were studied with regard to the degree of extirpation that was done based on the Simpson grading of meningioma resection. The postoperative course was monitored and the patients were assessed at the end of the first week of convalescence and after six weeks following surgery based on the GOS(Glasgow Outcome Scale) between 1-5 (worst- best).

All these parameters were included in the risk stratification and with special emphasis with respect to comorbidities, location, age, size and signs and symptoms and these were used for calculation of the CLASS scoring and grouping of patients based on this algorithm.

Based on the outcome as assessed by the GOS and the presence of complications (neurological and medical) the outcome evaluation of surgery was done for the three groups of patients under the various CLASS groups and the results were analyzed with regard to the success and otherwise of the surgery for the various types of meningiomas and the observations are presented.

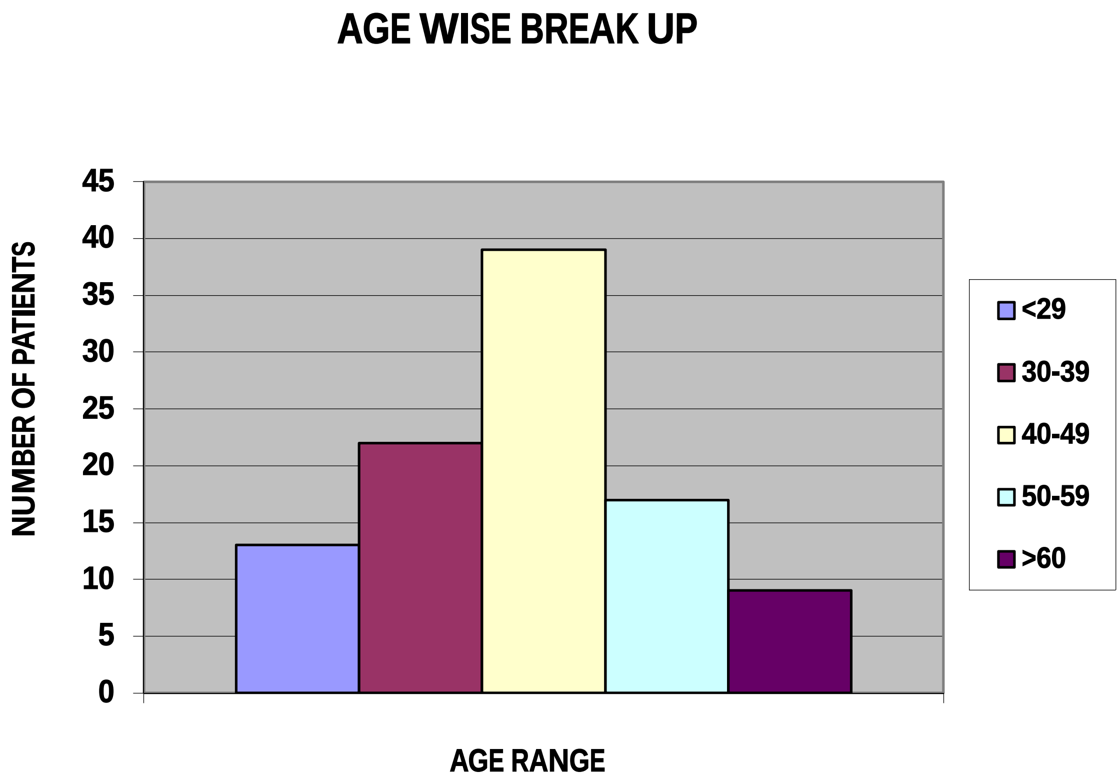
The information collected regarding all the selected cases were recorded in a Master Chart. Data analysis was done with the help of computer using **Epidemiological Information Package (EPI 2002).** Using this software, range, frequencies, percentages, means, standard deviations, Students‘t’ test, Chi square testand ‘p’ values were calculated. A 'p' value less than 0.05 is taken to denote significant relationship.

# RESULTS

The study encompasses the analysis of the evaluation done of about forty six patients who underwent surgery for meningiomas during the period 2009 to 2013.The patients were stratified on the basis of the CLASS algorithm and the outcome parameters were analysed.

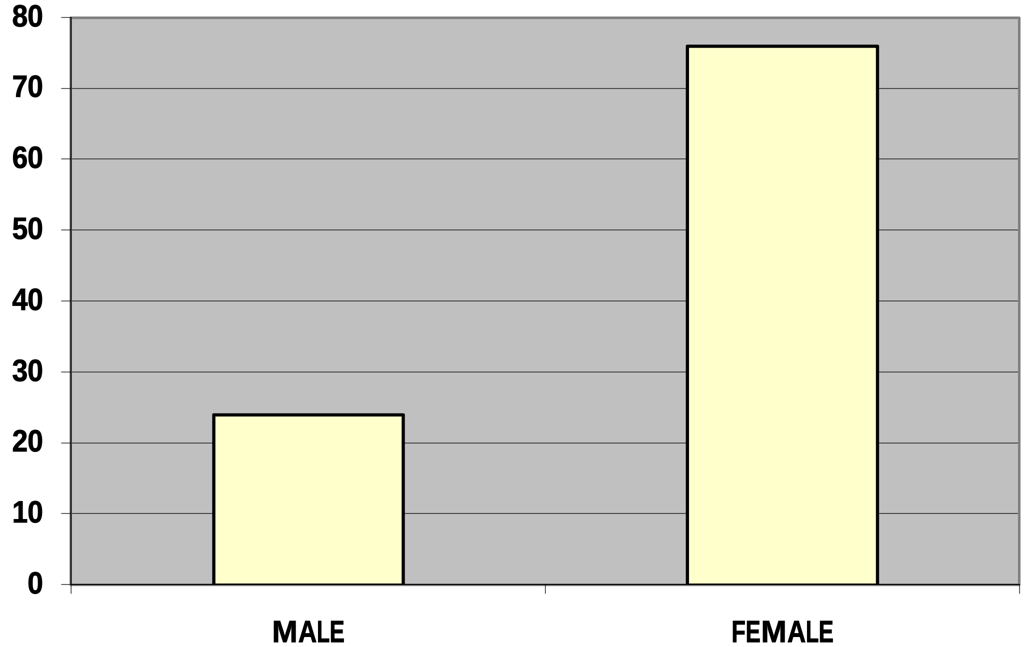
The demographic epidemiology of the forty six patients is as follows. The grouping of patient with respect to the age wise break up is

| **Age Range** | **No. of patients** | **Percentage** |
|---|---|---|
| < 29 | 6 | 13 |
| 30-39 | 10 | 22 |
| **40-49** | **18** | **39** |
| 50-59 | 8 | 17 |
| > 60 | 4 | 9 |




**The sex based incidence was as follows (M: F)**

| Sex | Number | Percentage |
|---|---|---|
| Male | 11 | 24 |
| Female | 35 | **76** |




With regard to the symptomatology of presentation the findings were as follows

| | | |
|---|---|---|
| Headache and vomiting | - | 38 |
| Headache alone | - | 2 |
| Seizures | - | 9 |
| Hemiparesis/Deficits | - | 3 |
| Behavioural disturbances | - | 2 |
| Diminution of vision | - | 7 |
| Papilledema | - | 3 |

The location of the lesion and the radiological correlate were found to be

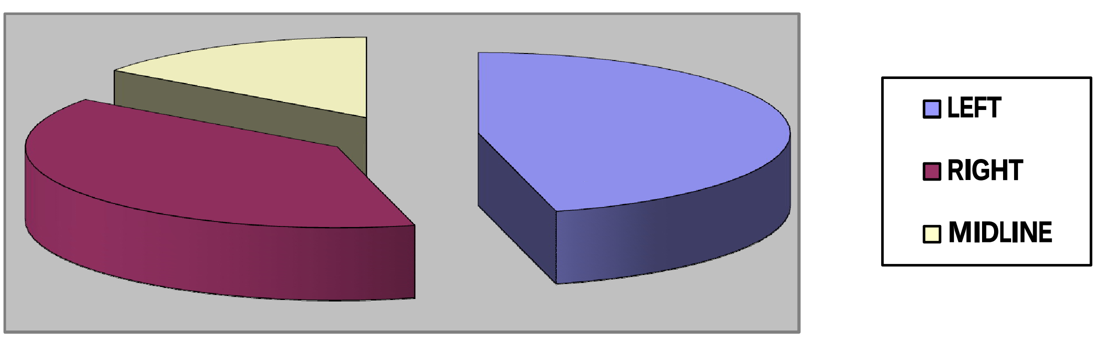
Left sided lesions - 21

Right sided lesions - 18

Midline structures - 7

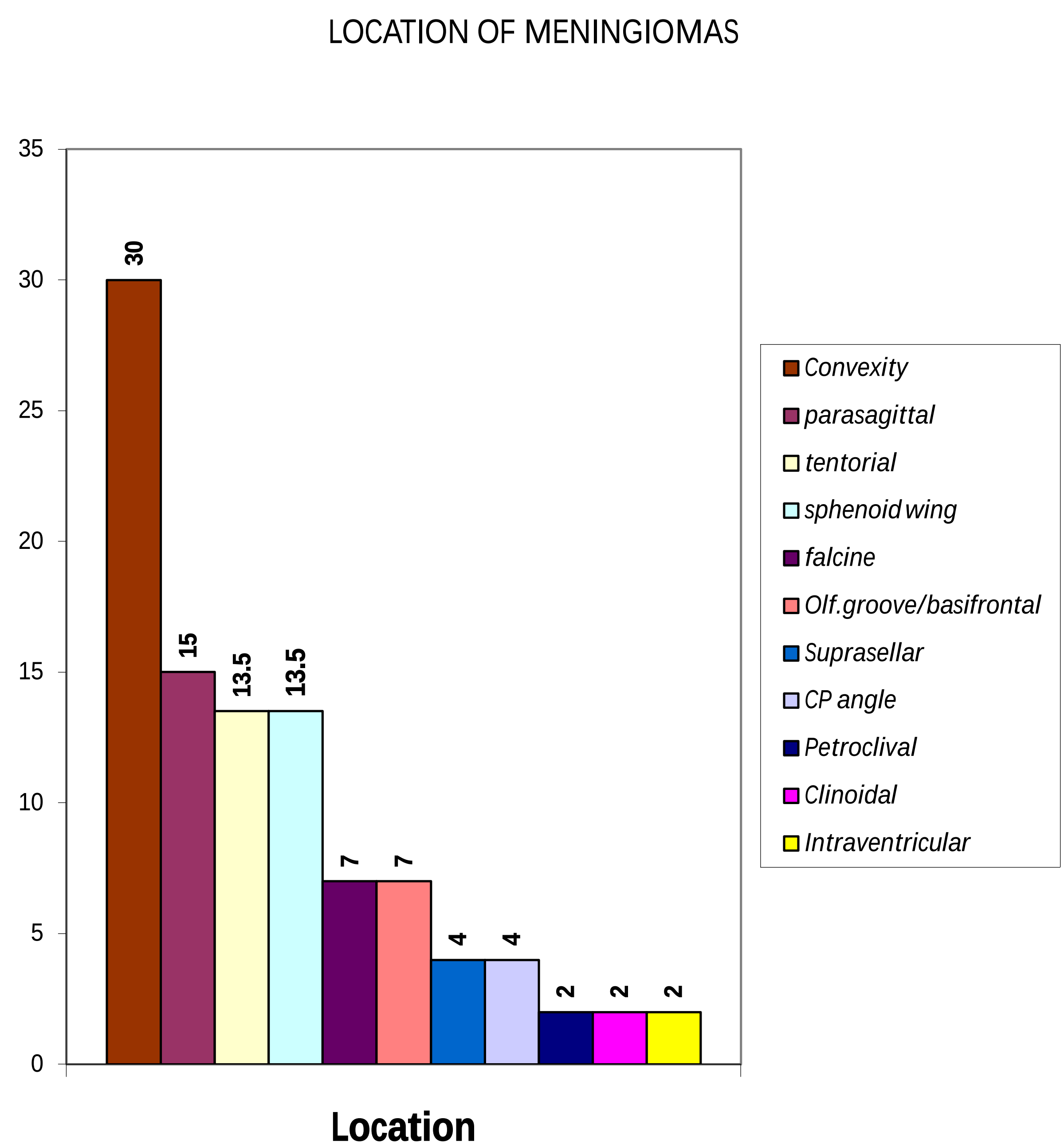
| Side of lesion | Number | Percentage |
|---|---|---|
| Left Sided Lesions | 21 | **46** |
| Right sided lesions | 18 | 39 |
| Midline lesions | 7 | 15 |

**SIDE OF LESION**



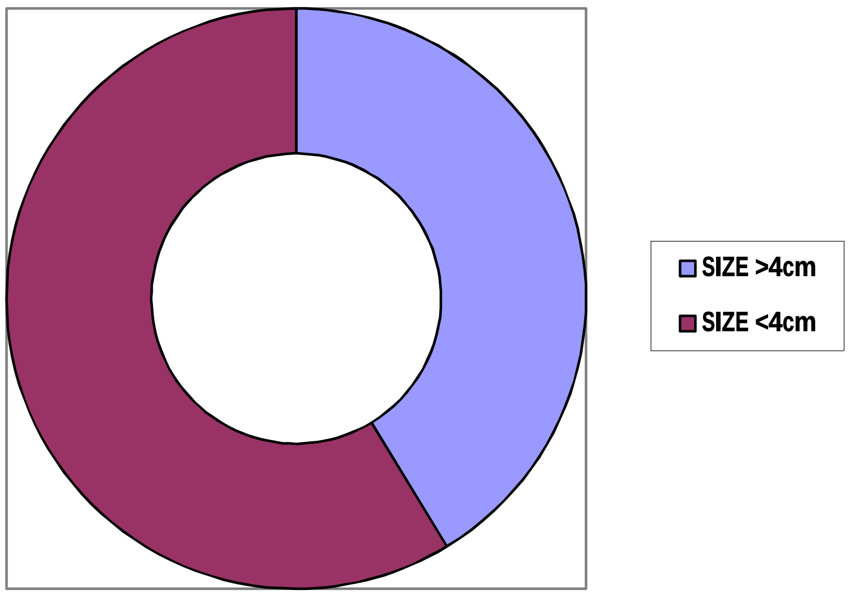
The anatomical location of the meningiomas as radiologically diagnosed and the findings were

| Location of the lesion | Number of patients | Percentage |
|---|---|---|
| **Convexity** | **14** | **30** |
| Parasagittal | 7 | 15 |
| Tentorial | 6 | 13.5 |
| Sphenoid wing | 6 | 13.5 |
| Falcine | 3 | 7 |
| Olfactory groove/Basifrontal | 3 | 7 |
| Suprasellar | 2 | 4 |
| Cerebellopontine angle | 2 | 4 |
| Petroclival | 1 | 2 |
| Clinoidal | 1 | 2 |
| Intraventricular | 1 | 2 |


LOCATION OF MENINGIOMAS
35
30
25
20
15
10
5
0
30
15
13.5
13.5
7
7
4
4
2
2
2
Convexity
parasagittal
tentorial
sphenoid wing
falcine
Olf.groove/basifrontal
Suprasellar
CP angle
Petroclival
Clinoidal
Intraventricular
Location

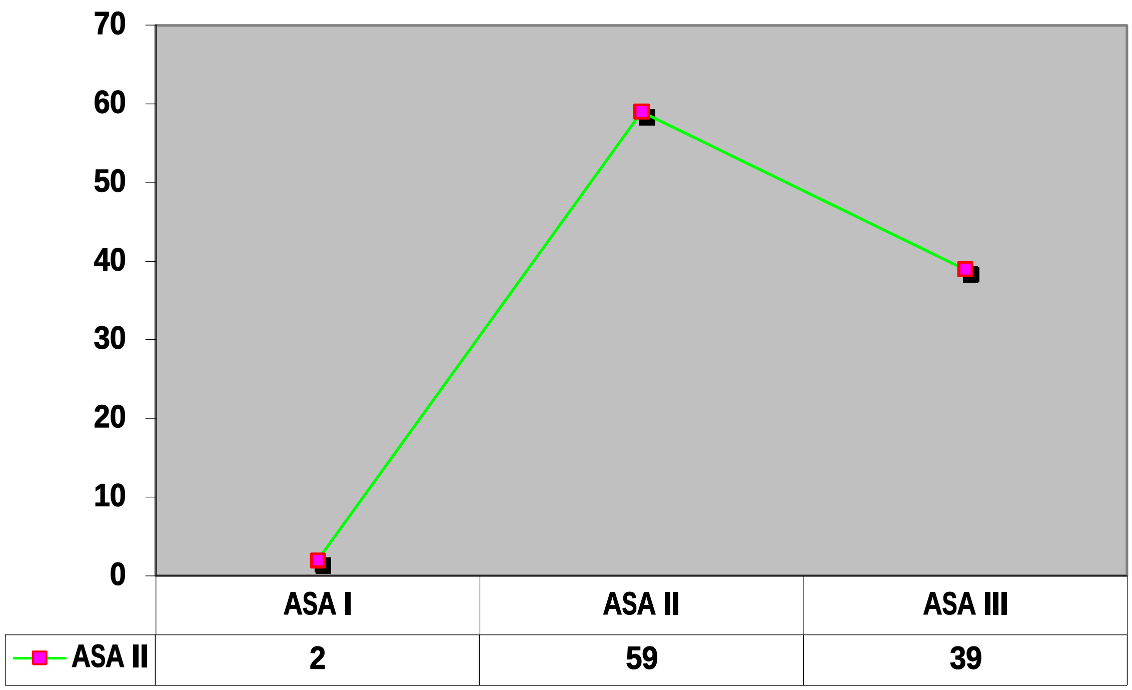
The other parameter that was diagnosed radiologically was with respect to the size of the lesion

| | | |
|---|---|---|
| Size greater than 4cm | - | 19 |
| Size less than 4cm | - | 27 |



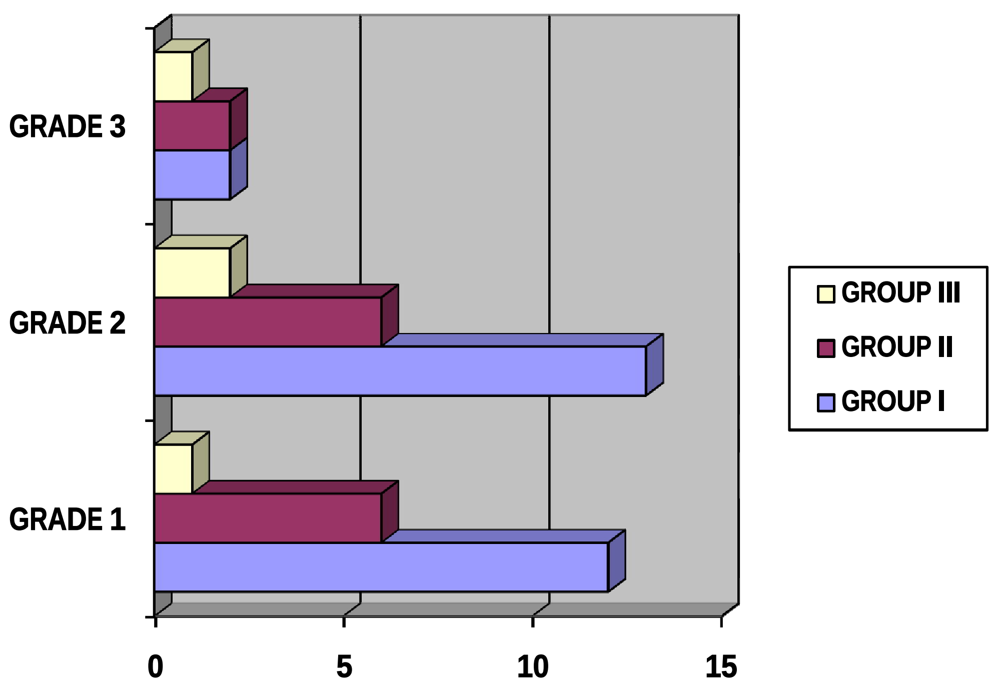
The preoperative functional status of the patient was analysed based on the ASA scale and the stratification was

| ASA stage | No. of patients | Percentage |
|---|---|---|
| **I** | 1 | 2 |
| **II** | 27 | **59** |
| **III** | 18 | 39 |



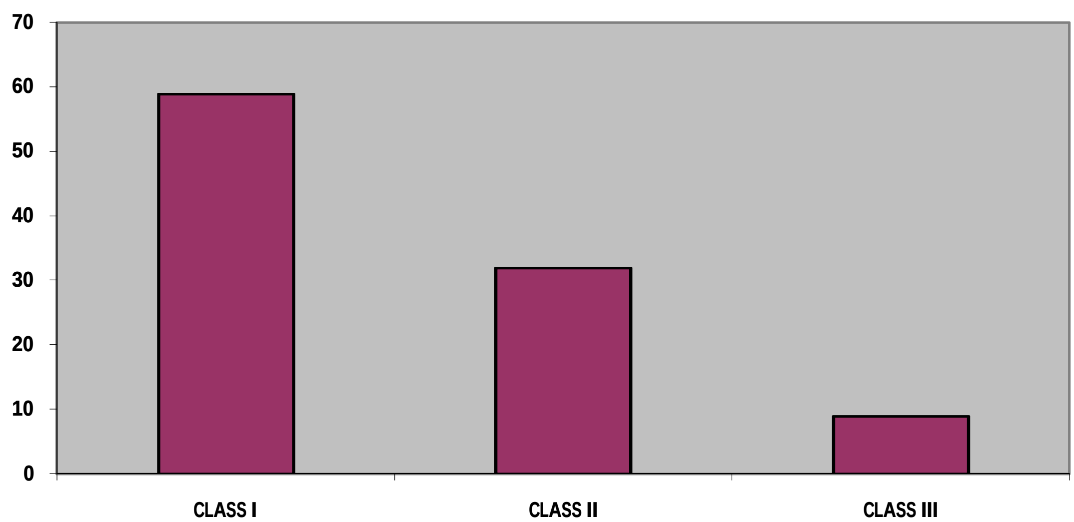
The grade of resection according to Simpson grading was also stratified and the results were

| | GRADE 1 | GRADE 2 | GRADE 3 | GRADE 4 |
|---|---|---|---|---|
| **GROUP I** | **12** | **13** | **2** | **0** |
| **GROUP II** | **6** | **6** | **2** | **1** |
| **GROUP III** | **1** | **2** | **1** | **0** |

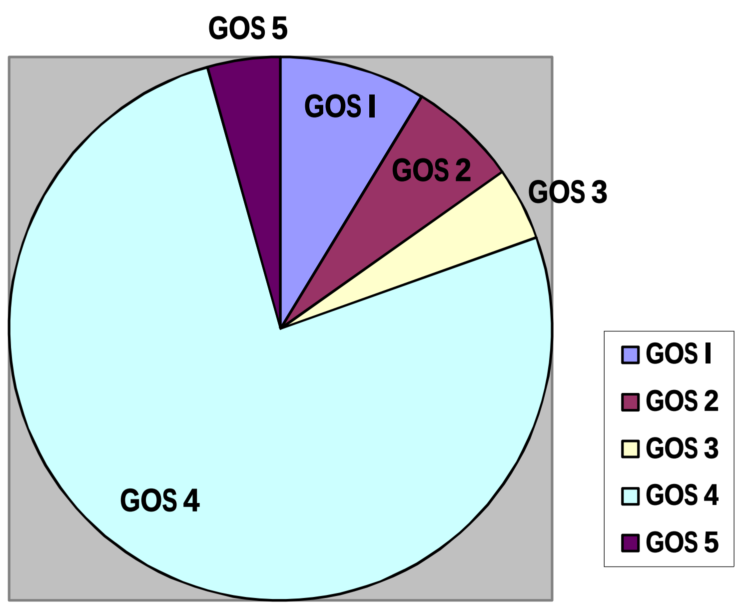


Based on the above findings with regard to the comorbidity, location,age, size and symptoms and signs of the various kinds of meningiomas in the sample evaluated the CLASS scoring was performed and the groups were assigned and the following findings were noted.

| **CLASS SCORING** | **NO.OF PATIENTS** | **PERCENTAGE** |
|---|---|---|
| CLASS I | 27 | **59** |
| CLASS II | 15 | **32** |
| CLASS III | 4 | **9** |



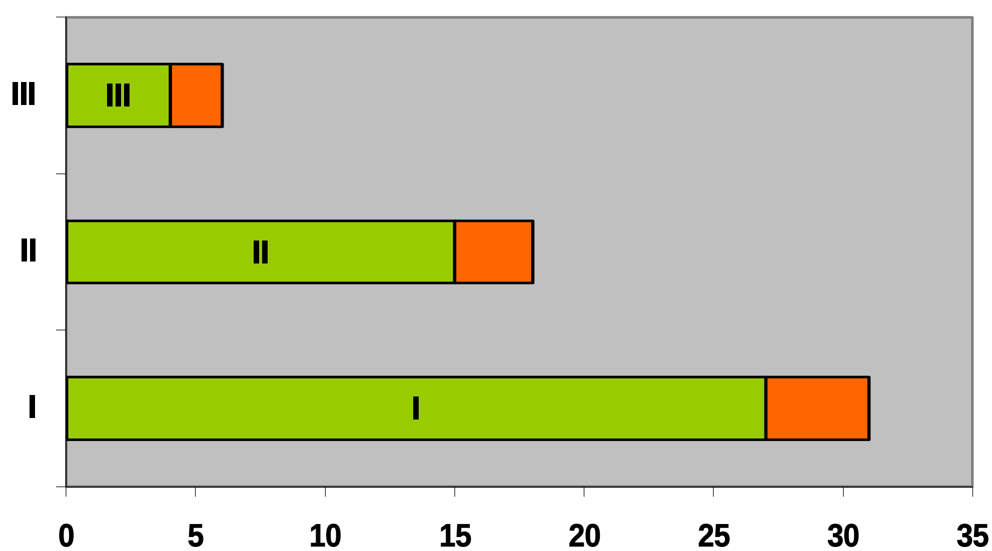
All patients were subject to surgical treatment and the results of the surgery was measured by the parameters of the Glasgow Outcome Scoring at the end of the period of 6 weeks post operatively. The overall GOS distribution was as follows




| GOS 1 | GOS 2 | GOS 3 | GOS 4 | GOS 5 |
|---|---|---|---|---|
| *4(9%)* | *3(7%)* | *2(4%)* | *35 (76%)* | *2 (4%)* |

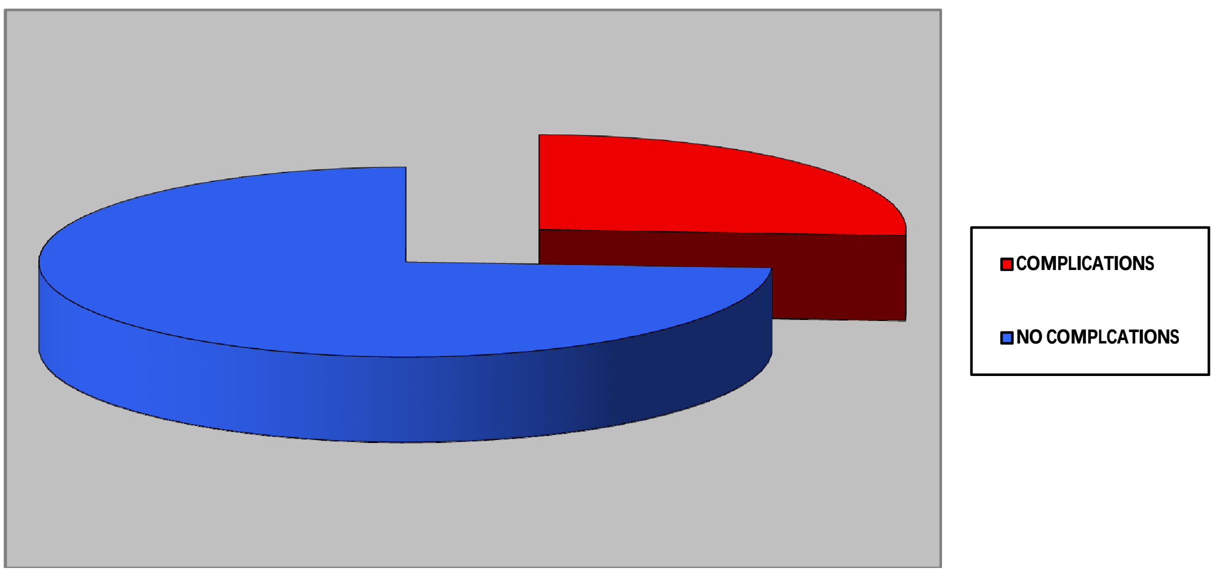
The scoring of the patients was done with GOS less than or equal to 3 taken as poor outcome and GOS more than 3 taken as representative of good outcome.

| CLASS GROUP | TOTAL | POOR OUTCOME | PERCENTAGE |
|---|---|---|---|
| I | 27 | 4 | 15 |
| II | 15 | 3 | 20 |
| III | 4 | 2 | 50 |



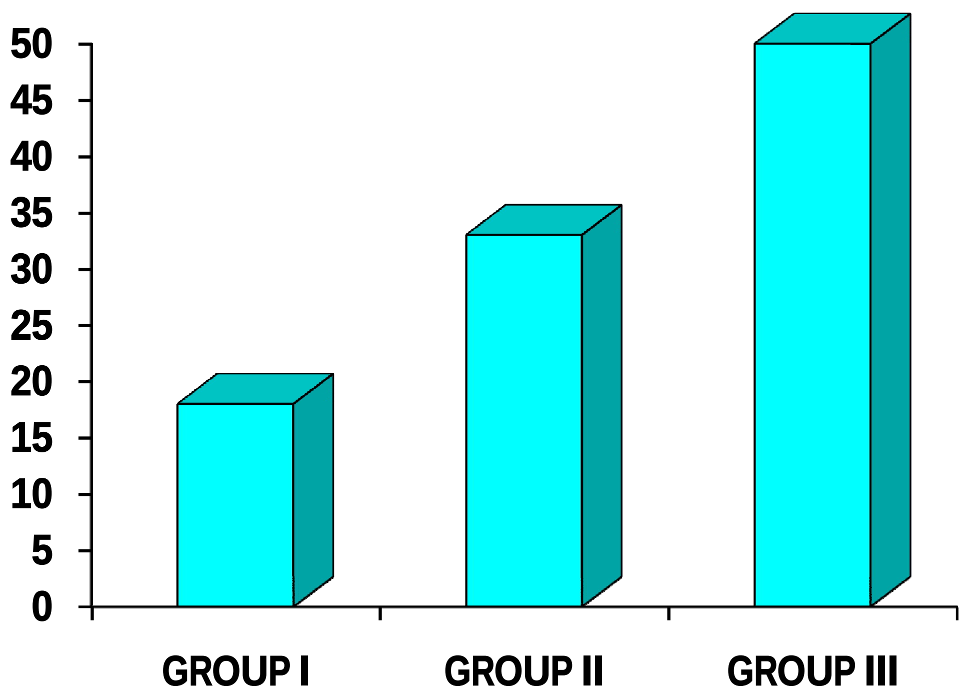
The outcome was also assessed on the basis of the postoperative neurological and medical complications that were also analyzed.

| TOTAL SURGERIES | COMPLICATIONS | NO COMPLICATIONS |
|---|---|---|
| **46** | **12(26%)** | **34(74%)** |



The grouping of the complications observed with respect to the stratification by the CLASS algorithm is observed as follows

| CLASS GROUPING | COMPLICATIONS | PERCENTAGE |
|---|---|---|
| **GROUP I** | **5/27** | **18** |
| **GROUP II** | **5/15** | **33** |
| **GROUP III** | **2/4** | **50** |



The distribution of the type of complications included wound related predominantly pseudomeningocele and neurological complications such as visual deterioration,hemiparesis,aphasia and behavioral disturbances.

The study also included medical complications the most important of which was deep vein thrombosis leading on to pulmonary embolism and the overall mortality was 3/46 (2 of which were due to associated medical complications).

# DISCUSSION

The study encompasses the results of the analysis of 46 patients who underwent surgical treatment for meningiomas in the Department of Neurosurgery at Government Rajaji Hospital Madurai.

The epidemiological analysis revealed that the incidence of meningiomas in terms of occurrence was more common in the age group of 40-49 with 39% of patients presenting in this age group closely followed by the age group of 30-39 with 22% compared to the occurrence of these tumours in the age group of 55.9-56.4 years as reported by Das et al. and compared to the Western population incidence of 55-64 as is revealed by the CBTRUS study with an incremental incidence with increasing age.[1]

The overall ratio of sexual preponderance of meningiomas heavily tilts towards the female sex with three times more likely incidence and an odds ratio of 10.02 indicating ten times the odds of developing eningiomas.

| | | | |
|---|---|---|---|
| **Male : Female** | **24:76** | **1:3** | **OR -10.02** |

This is in comparison to the male to female ratio of 1:1.4 to 2.6 as reported by Alesssandro[52] et al and Rohringer[5] et al.

With regard to the primary symptomatology of presentation the study indicates that the most common symptom is headache and vomiting both of which are nonspecific in the sense that no localization could be attributed to the headache as was evidenced in 40 of 46 patients about 86.9% of the total sampled.

The side of lesion as was exemplified in the study was of the distribution of a slightly predominant left sided occurrence of 46% compared to 39% which were right sided and 15% midline location.

The location of the meningioma was of the order that convexity meningiomas were the most common accounting for about 30% of the lesions with parasagittal and falcine meningiomas making up about 22% of the lesions and this is in correlation to the results reported by Christiansen[53] et al and Kloeboe[54] et al

| Location of the lesion | Observed | Kloebe et al |
|---|---|---|
| **Convexity** | **30** | **19** |
| Parasagittal/falcine | 22 | 25 |
| Tentorial | 13.5 | 3 |
| Sphenoidal | 15.5 | 17 |
| Olfactory groove/Basifrontal | 7 | 8 |
| Suprasellar | 4 | 9 |
| Posterior fossa | 6 | 8 |
| Intraventricular | 2 | 2 |

The observed ‘p’ value was about 0.4 by the t test.

With regard to the size of the lesions the findings of the study were of the order that 59% of lesions measuring less than 4cm and 41% of lesions were greater than 4cm with no significant odds ratio of occurrence.

The stratification of patients according to the CLASS algorithm revealed that 59% of patients were placed in group I, 32% of patients in

Group II and 9% of patients in Group III. This was evaluated in comparison to the study by Lee et al.

| CLASS scoring | Observed | Lee et al. | |
|---|---|---|---|
| GROUP I | 59 | 36.3 | Chi square test p value= **0.0002** |
| GROUP II | 32 | 51.4 | |
| GROUP III | 9 | 12.3 | |

The preoperative morbidity status of the patients analyzed in the study was of the finding of 59% of patients placed in the ASA II category and 39% of patients in the ASA III category as compared to the 42.6-46% in the ASA II category as observed by Lee et al.

| CLASS group/ASA / STUDY | CLASS GROUP I ASA II | CLASS GROUP II ASA II | T TEST |
|---|---|---|---|
| Observed | 55 | 53 | |
| Lee et al. | 42 | 47.5 | **p=.04** |

The analysis of grade of resection with respect to the CLASS algorithm grouping was elucidated as 44% of group I patients undergoing grade 1 resection and 40% of group II and 25% of group III undergoing grade 1 resection.

The outcome parameters of the surgical methodology adopted with reference to the CLASS stratification was then analyzed in reference to the Glasgow Outcome Scoring and compared with the results obtained by Lee et al.

| **GOS Scoring** | **Observed** | **Lee et al** | |
|---|---|---|---|
| GOS 4-5 | 80 | 95.6 | Student's 't' test<br>**p value=0.5** |
| GOS 1-3 | 20 | 4.4 | |

The outcome of surgical intervention based on the 'CLASS' scoring with respect to the poor outcome as measured by the GOS score of 1-3 was observed to be about 15% in Group I and 20% in Group II and about 50% in Group III and the statistical analysis correlated with Lee et al. (p value-.04)

The calculated odds ratio comparison of Group III to Group I was 5.6 and Group III to Group II was 1.4

<table>
<tr><th>CLASS Group</th><th>Observed</th><th>Lee et al</th><td rowspan="4">Student’s ‘t’ test<br><br>p value=0.04</td></tr>
<tr><td>I</td><td>15</td><td>1.8</td></tr>
<tr><td>II</td><td>20</td><td>3.9</td></tr>
<tr><td>III</td><td>50</td><td>16.2</td></tr>
</table>

Odds ratio of having unfavourable outcome according to the CLASS score was compared and the analysis is

| CLASS SCORE | Odds ratio-observed | Odds ratio-Lee et al |
|---|---|---|
| **Group III vs.Group I** | ***5.6*** | ***10.36*** |
| **Group II vs. Group I** | ***1.4*** | ***2.17*** |

The post operative complications observed in the study with respect to the grouping according to the CLASS algorithm analysis according to the odds ratio was calculated as 4.55 when Group III and Group I was compared and 2.03 when Group II and Group I were compared indicative of a prominent and higher probability of occurrence of complications.

| **COMPLICATIONS** | **Observed odds ratio** | **Lee et al . Odds ratio** |
|---|---|---|
| Group III vs. Group I | ***4.55*** | ***4.06*** |
| Group II vs.Group I | ***2.03*** | ***2.33*** |

| **CLASS GROUPING** | **OBSERVED - Complications** | **Lee et al – Complications** |
|---|---|---|
| **GROUP I** | 18 | 7.3 |
| **GROUP II** | 33 | 15.6 |
| **GROUP III** | 50 | 24.3 |

Student's 't' test –**p value = .02**

# CONCLUSION

The overall results and conclusions from the study corroborate the following findings were on the basis of the results of the observations on the forty six patients in the study.

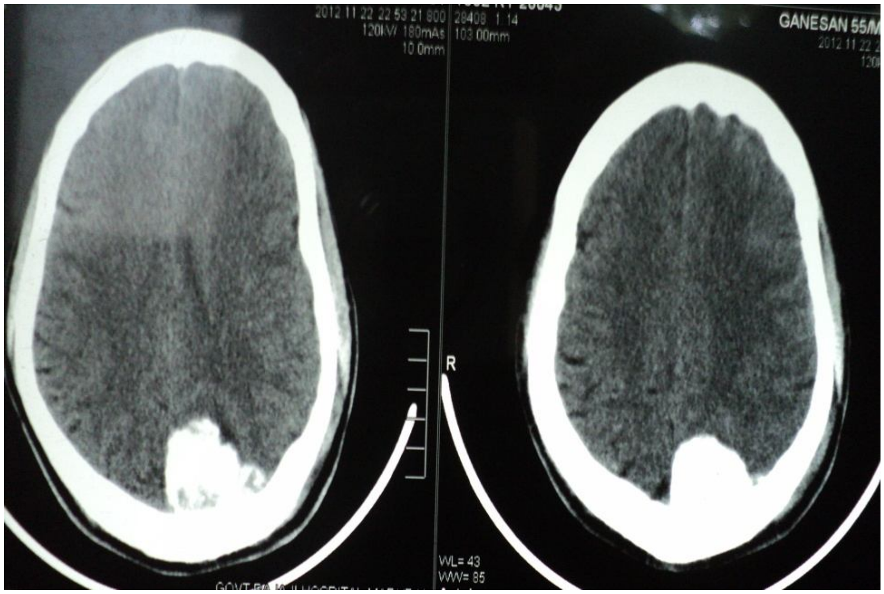
The epidemiological conclusions were that the incidence of meningiomas is highest in the fourth decade with a marked preponderance of lesions in females.

The primary symptomatology is headache of a non-localizing variety accompanied by vomiting. Most of these symptoms were mild to moderate in intensity and severity.

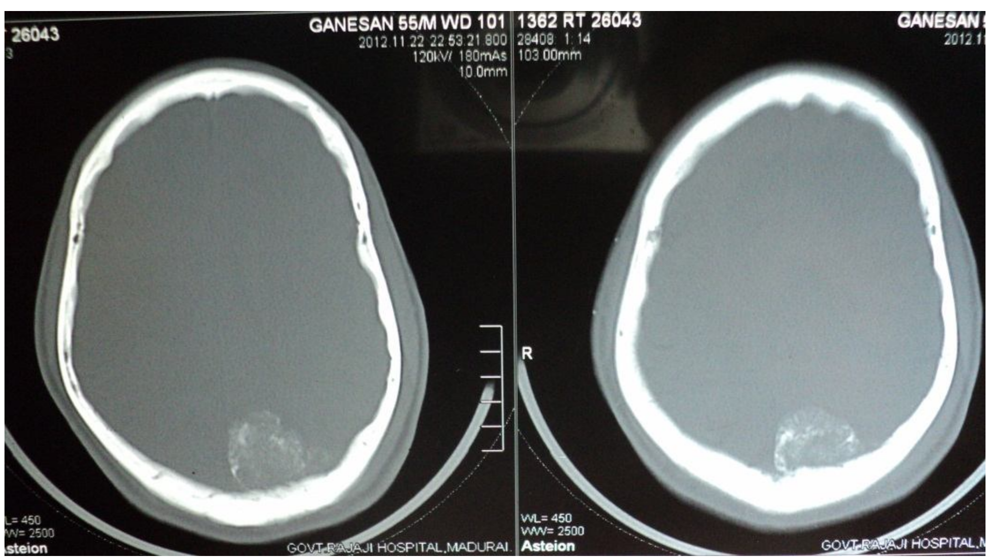
With regard to the imaging findings the location of the lesion was more in the convexities of the cerebral hemispheres followed by the parasagittal/falcine varieties and tentorial and sphenoid wing varieties with no specific predilection for side and midline located lesions formed a third of these varieties.

“CLASS” algorithm forms a viable alternative for preoperative standardization and stratification of meningiomas and the validity of the algorithm is very well demonstrated by this study as is evidenced by the higher correlation of complications and poor outcome in the Group III patients.

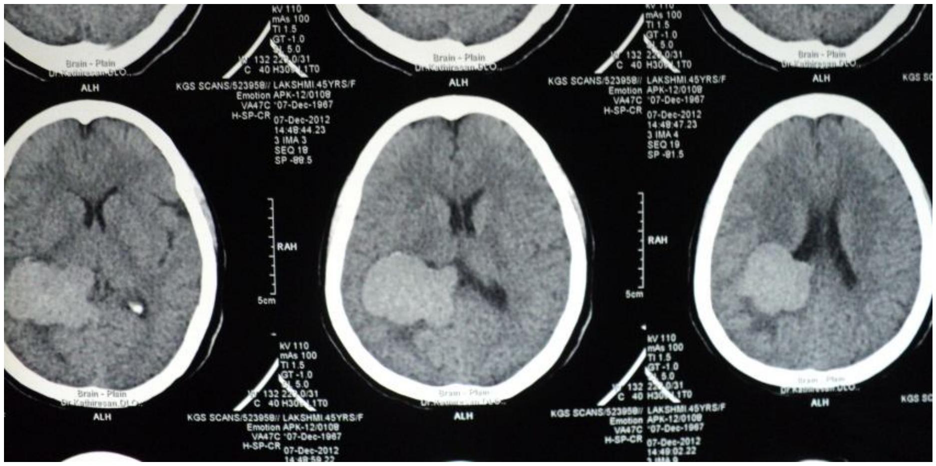
The “CLASS” algorithm thus helps in effective risk factor analysis and in helping to predict the risk benefit ratio in patients with meningiomas and in eventual identification of those subjects who would benefit the most in relation to the preoperative characteristics and the patient associated morbidities because of the ease in applicability and utility as is evidenced by the comparative results in this study.



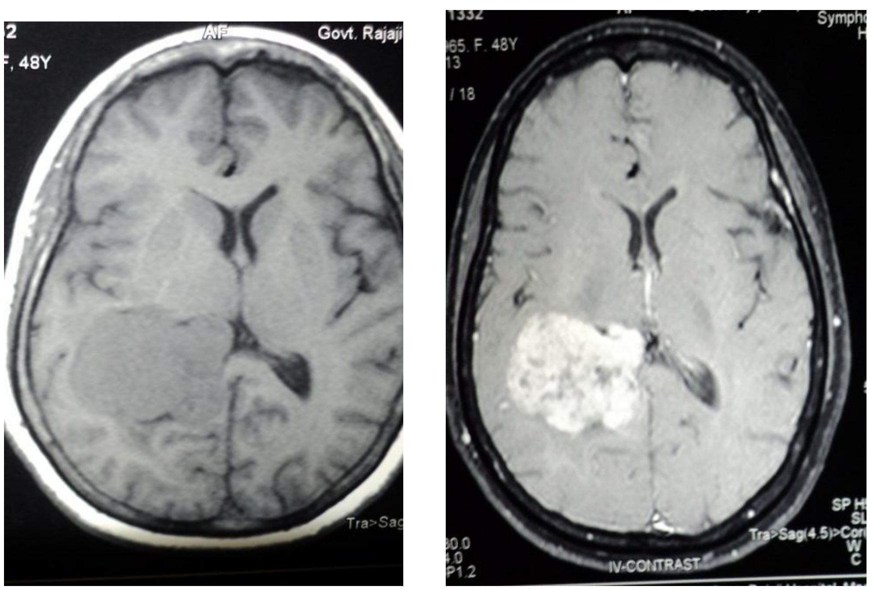

Convexity meningioma-calcified



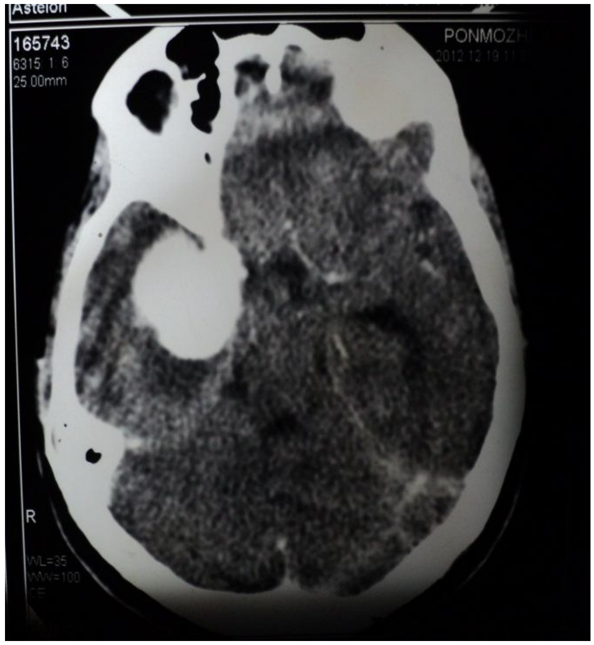

Convexity meningiomas-Bone window



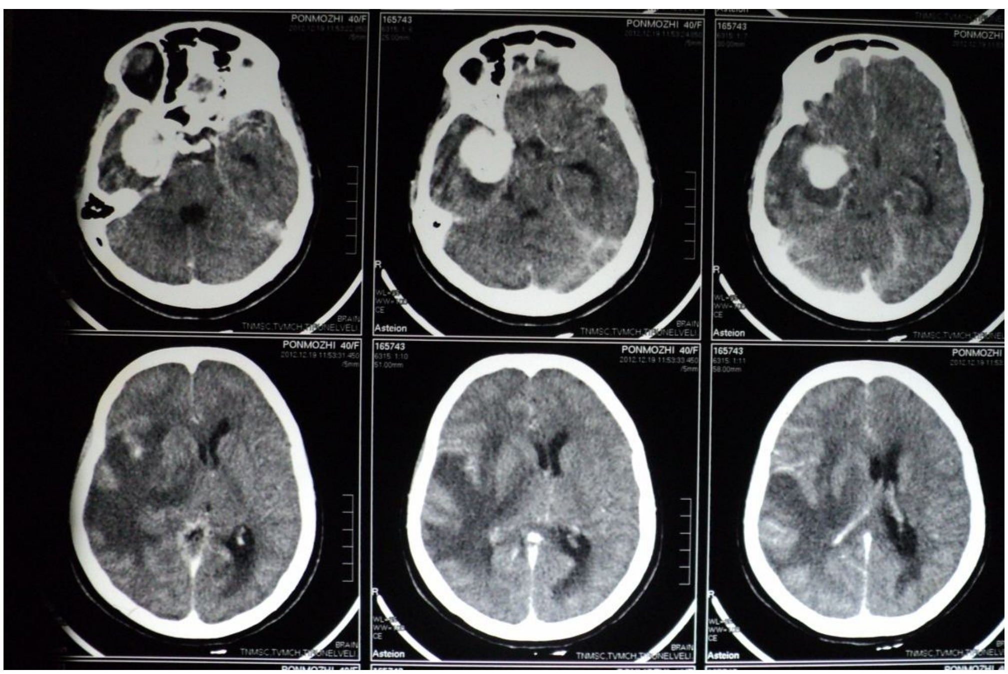
Intraventricular Meningiomas-CT Scan

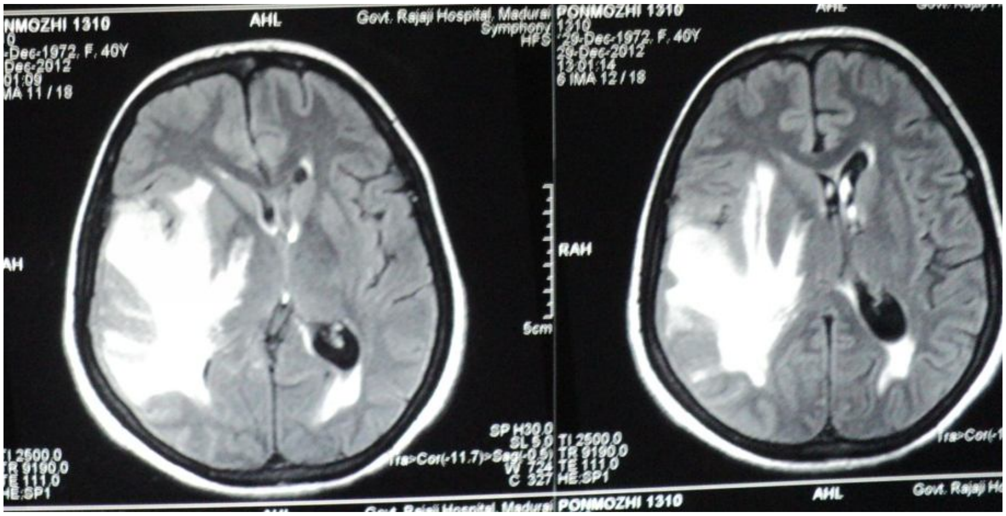



Intraventricular meningioma-MRI T1w (left)/ T1W contrast (right)

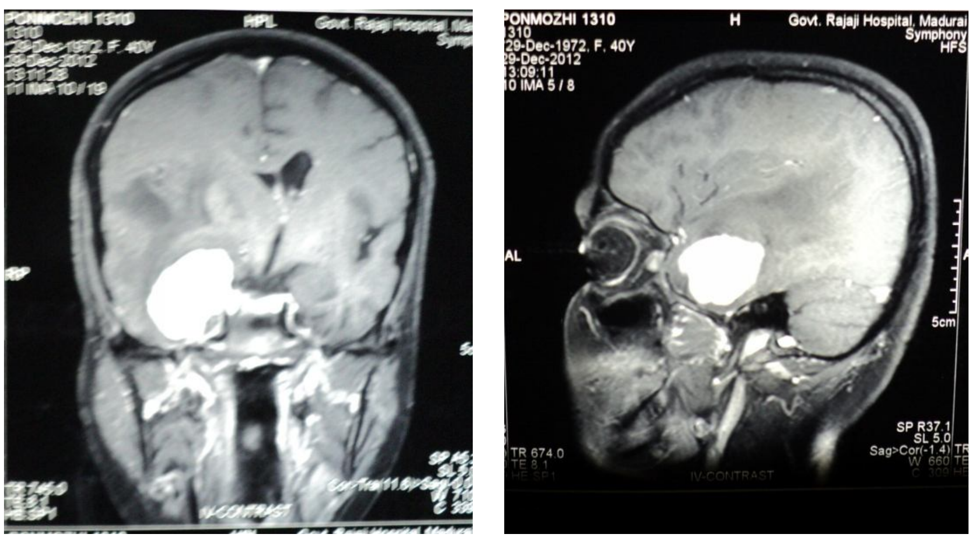



Clinoidal Meningiomas-CT Scan

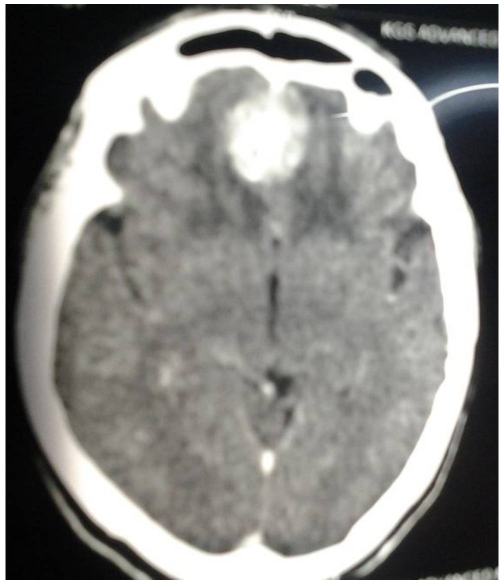




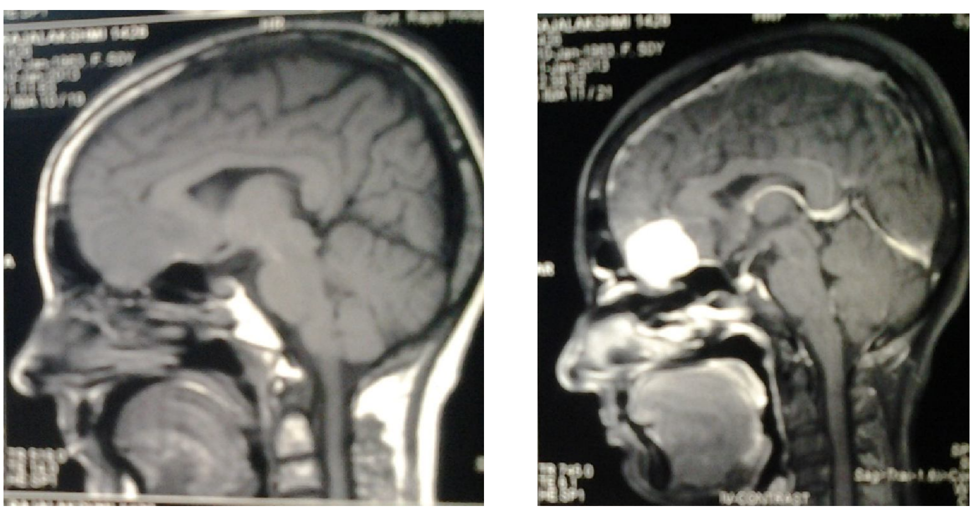

Clinoidal meningiomas-MRI FLAIR




Clinoidal Meningioma-Coronal(left)/Sagittal (right)



Basifrontal meningioma-CT Scan



Basifrontal meningioma-T1W(left)/T1W contrast (right)

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## STUDY PROFORMA AND QUESTIONNAIRE

| | |
|---|---|
| Name | : |
| Age/Sex | : |
| MRD No. | : |
| DOA/DOS/DOD | : |
| Complaints | : |
| Comorbidities | : |
| Location of lesion | : |
| Size of Lesion (MRI/CT) | : |
| ASA status | : |

Surgical Details

Intraoperative Findings :

Simpson Grade of Resection :

Postoperative Course :

Histpathological grade (WHO grading) :

Other factors :

Glasgow Outcome Score :

CLASS Score

COMORBIDITY :

LOCATION :

AGE :

SIZE :

SIGNS/SYMPTOMS

Ref. No. 990/E4/3/2012 | Govt. Rajaji Hospital, Madurai.20. Dated: .03.2013

**Institutional Review Board / Independent Ethics Committee.**
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Dean, Madurai Medical College & 2521021
Govt Rajaji Hospital, Madurai 625020.
**Convenor**
grhethicssecy @gmail.com.

**Sub:** Establishment-Govt. Rajaji Hospital, Madurai-20-
Ethics committee-Meeting Minutes- approval -regarding.

The Ethics Committee meeting of the Govt. Rajaji Hospital, Madurai was held at 10.00 am to 12.00.pm on 25.02.2013 at the Surgery Seminar Hall, Govt. Rajaji Hospital, Madurai. The following members of the committee have attended the meeting.

| | | |
|---|---|---|
| 1.Dr. V. Nagarajan, M.D., D.M (Neuro)<br>Ph: 0452-2629629<br>Cell.No 9843052029 | Professor of Neurology (Retired)<br>D.No.72, Vakkil New Street,<br>Simmakkal, Madurai -1 | Chairman |
| 2. Dr.Mohan Prasad , M.S M.Ch<br>Cell.No.9843050822 (Oncology ) | Professor & H.O.D of Surgical Oncology(Retired)<br>D.No.72, West Avani Moola Street,<br>Madurai -1 | Member Secretary |
| 3. Dr.L. Santhana Lakshmi,MD<br>Cell.No 9842593412 | Associate Professor of Physiology/V.P<br>Madurai Medical College | Member |
| 4. Dr. Parameswari M.D (Pharmacology)<br>Cell.No.9994026056 | Director of Pharmacology<br>Madurai Medical College | Member |
| 5. Dr.Moses K.Daniel MD(Gen.Medicine)<br>Cell.No 09842156066 | Professor & H.O.D of Medicine<br>Madurai Medical College | Member |
| 6. Dr.D. Soundara Rajan,MS(Gen.Surgery)<br>Cell.No 9842120127 | Professor & H.O.D of Surgery<br>Madurai Medical College | Member |
| 7. Dr.Angayarkanni MD(O&G)<br>Cell.No 9443567724 | Professor & H.O.D of O&G<br>Madurai Medical College | Member |
| 8. Dr.P.V. Pugalenthi M.S, (Ortho)<br>Cell.No 9443725840 | Professor & H.O.D Ortho<br>Madurai Medical College | Member |
| 9. Dr. M. Sundarajan M.S., Mch<br>Cell.No 9994924369 (Neuro Surgery) | Professor (Neuro Surgery)<br>Madurai Medical College | Member |
| 10 Thiru..Pala. .Ramasamy , BA.,B.L.,<br>Cell.No 9842165127 | Advocate,<br>D.No.72.Palam Station Road,<br>Sellur, Madurai -2 | Member |
| 11. Thiru. P.K.M. Chelliah ,B.A<br>Cell.No 9894349599 | Businessman, 21 Jawahar Street,<br>Gandhi Nagar, Madurai-20. | Member |

Following Project was approved by the committee

| Name of P.G. | Course | Name of the Project | Remarks |
|---|---|---|---|
| Dr. G.M. Niban | PG in M.Ch., (Neurosurgery) Govt. Rajaji Hospital & Madurai Medical College, Madurai. | Evaluation of risk factors influencing surgical outcome in meningiomas with "Class" Algorithm" | Approved |

Please note that the investigator should adhere the following: She/He should get a detailed informed consent from the patients/participants and maintain Confidentially.

1. She/He should carry out the work without detrimental to regular activities as well as without extra expenditure to the institution to Government.
2. She/He should inform the institution Ethical Committee in case of any change of study procedure site and investigation or guide.
3. She/He should not deviate for the area of the work for which applied for Ethical clearance.

She/He should inform the IEC immediately, in case of any adverse events pr Serious adverse reactions.

4. She/he should abide to the rules and regulations of the institution.
5. She/He should complete the work within the specific period and apply for if any Extension of time is required She should apply for permission again and do the work.
6. She/He should submit the summary of the work to the Ethical Committee on Completion of the work.
7. She/He should not claim any funds from the institution while doing the word or on completion.
8. She/He should understand that the members of IEC have the right to monitor the work with prior intimation.

**Member Secretary** **Chairman**

**DEAN/Convenor**
**Govt. Rajaji Hospital,**
**Madurai- 20.**

**To**
**The above Applicant**
**-thro. Head of the Department concerned.**

## MASTER CHART-CLASS Algorithm

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | MUTHURAKKU | 55/F | 84307 | 22/10/09 | LT.TEMPORAL | 4X3 | Headache/vomiting | III | -1 | GRADE 1 | 1 | Improved | 4 |
| 2 | RAJATHI | 55/F | 88713 | 26/10/09 | LT.TEMPOROPARIETAL | 4X4 | Headache/vomiting | III | 0 | GRADE 1 | 1 | Improved | 4 |
| 3 | RAVICHANDRAN | 42/M | 95602 | 16/11/09 | LT.SPHENOID WING | 4X4 | Headache/giddiness | II | 1 | GRADE 2 | 1 | Improved | 4 |
| 4 | GORIMA | 40/F | 07562 | 03/02/11 | RT.FRONTAL CONVEXITY | 5X5 | Headache/Seizures | II | 2 | GRADE 1 | 1 | Improved | 4 |
| 5 | THANGAM | 23/F | 11721 | 21/02/11 | RT.TENTORIAL | 3X3 | Headache/papilledema | II | 2 | GRADE 2 | 1 | Improved | 4 |
| 6 | PETCHIAMMAL | 36/F | 13749 | 02/03/11 | RT.PARIETAL | 4X5 | Headache/weakness | II | 3 | GRADE 1 | 2 | Improved | 4 |
| 7 | BOSE | 62/M | 17888 | 21/03/11 | LT.SPHENOID WING | 3X3 | Headache/vomiting | III | -2 | GRADE 2 | 1 | Improved | 4 |
| 8 | THANGAM | 23/F | 18738 | 24/03/11 | LT.TENTORIAL | 4X3 | Headache/vomiting | II | -1 | GRADE 2 | 1 | pseudomeningocele | 4 |
| 9 | GOMATHY | 45/F | 27419 | 02/05/11 | RT.TENTORIAL | 3X3 | Headache/vomiting | II | -1 | GRADE 2 | 1 | Improved | 4 |
| 10 | SUDHAKAR | 31/M | 29309 | 10/05/11 | LT.CONVEXITY | 5X4 | Headache/Seizures | II | 2 | GRADE 1 | 1 | Improved | 4 |
| 11 | KANNAN | 27/M | 31932 | 21/05/11 | RT.PARASAGITTAL | 5X5 | Headache/vomiting | II | 1 | GRADE 2 | 1 | Improved | 4 |
| 12 | SHANTHI | 18/F | 39651 | 16/06/11 | LT.PARIETAL COMVEXITY | 5X5 | Headache/Seizures | II | 2 | GRADE 1 | 1 | Improved | 4 |
| 13 | BALAMMAL | 40/F | 38067 | 16/06/11 | RT.PETROCLIVAL | 4X3 | Headache/vomiting | II | 0 | GRADE 2 | 1 | Improved | 4 |
| 14 | NALLAMMAL | 55/F | 45177 | 19/07/11 | OLFACTORY GROOVE | 3X2 | Headache/papilledema | II | 1 | GRADE 2 | 1 | Improved | 4 |
| 15 | YESUNAYAGI | 55/F | 57078 | 07/09/11 | LT. TEMPORAL | 3X3 | Headache/vomiting | III | -1 | GRADE 1 | 2 | behavioural changes | 3 |
| 16 | MURUGAN | 40/M | 57140 | 09/09/11 | LT.SPHENOID WING | 4X4 | Headache/vomiting | II | 1 | GRADE 2 | 1 | Improved | 4 |
| 17 | RANJITHAM | 52/F | 58255 | 13/09/11 | LT.FRONTOPARIETAL | 3X3 | Headache/Seizures | II | 1 | GRADE 1 | 1 | Improved | 4 |
| 18 | JEYARANI | 65/F | 72296 | 27/09/11 | RT.PARIETAL CONVEXITY | 5X5 | Headache/Seizures | III | 0 | GRADE 1 | 1 | Improved | 4 |
| 19 | JANAKI | 40/F | 83922 | 17/11/11 | LT.PARAFALCINE | 4X3 | Headache/vomiting | II | 0 | GRADE 2 | 1 | Rt. Hemiparesis | 4 |
| 20 | AZHAGI | 40/F | 76817 | 30/11/11 | RT.TENTORIAL | 4x4 | Headache/Papilledema | III | -2 | GRADE 1 | 1 | Pseudomeningocele | 2 |
| 21 | PETCHIAMMAL | 36/F | 86988 | 01/12/11 | LT.CONVEXITY | 5X4 | Headache/Seizures | II | 2 | GRADE 1 | 1 | Improved | 4 |
| 22 | VELLAYAMMAL | 45/F | 81356 | 13/12/11 | RT.FRONTAL CONVEXITY | 5x4 | Headache/incontinence | III | 1 | GRADE 1 | 1 | Improved | 4 |

# MASTER CHART-CLASS Algorithm

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 23 | MARIAMMAL | 42/F | 06456 | 24/01/12 | RT. FRONTAL CONVEXITY | 4x3 | Headache/Blurred vision | **III** | **0** | GRADE 1 | 1 | Improved | **4** |
| 24 | ANANDHI | 28/F | 09265 | 07/02/12 | RT.ANT.PARASAGITTAL | 5x4 | Headache/Blurred vision | **III** | **2** | GRADE 1 | 1 | Improved | **4** |
| 25 | ADAIKKALAM | 45/M | 26208 | 16/04/12 | RT.FRONTAL SUBFALCINE | 3x4 | Headache/Papilledema | **III** | **1** | GRADE 3 | 1 | Improved | **4** |
| 26 | SHANMUGHAM | 40/M | 35905 | 22/05/12 | SUPRASELLAR | 3x3 | Bil.dim.vision | **III** | **-2** | GRADE 3 | 1 | Visual defect/behavioural def | **2** |
| 27 | DEVI | 47/F | 45723 | 27/06/12 | LT.FRONTAL PARASAGITTAL | 4x3 | Behaviour disturbances | **III** | **0** | GRADE 3 | 1 | Behavioual/hemiparesis | **1** |
| 28 | VELU | 57/M | 49474 | 13/07/12 | RT.SPHENOID WING | 3x2 | Bil.dim.vision/giddiness | **III** | **0** | GRADE 2 | 1 | Improved | **4** |
| 29 | IRULAYEE | 60/F | 82993 | 27/07/12 | LT.CP ANGLE | 4x4 | Headache/vomiting | **III** | **1** | GRADE 2 | 1 | Pseudomeningocele | **1** |
| 30 | NABISATH ISIRIYA | 45/F | 56039 | 09/08/12 | RT.SPHENOID RIDGE | 5x5 | Headache/vomiting | **III** | **2** | GRADE 1 | 1 | Improved | **4** |
| 31 | ARUKKANI | 75/F | 60775 | 29/08/12 | RT.BASIFRONTAL | 3x3 | Headache/vomiting | **III** | **-3** | GRADE 2 | 1 | Improved | **4** |
| 32 | MEENA | 32/F | 62465 | 04/09/12 | LT.PARASAGITTAL | 3x2 | Headache/vomiting | **II** | **0** | GRADE 2 | 2 | Improved | **4** |
| 33 | RAJENDRAN | 52/M | 64260 | 11/09/12 | LT.LATERAL SPHENOID | 5x4 | Headache | **II** | **1** | GRADE 2 | 1 | Improved | **4** |
| 34 | THILAGAVATHY | 37/F | 65084 | 14/09/12 | RT.TENTORIAL | 5x4 | Headache | **II** | **2** | GRADE 2 | 1 | Improved | **4** |
| 35 | ALASUBRAMANIAN | 30/M | 65720 | 28/09/12 | LT. FRONTAL CONVEXITY | 5x3 | Headache/Diplopia | **III** | **1** | GRADE 1 | 1 | Improved | **4** |
| 36 | PALANIAMMAL | 45/F | 69983 | 03/10/12 | SUPRASELLAR | 3x2 | Bil.Optic Atrophy | **II** | **-1** | GRADE 4 | 1 | Visual deterioration | **2** |
| 37 | IUTHUKRISHNAVEN | 18/F | 74694 | 20/10/12 | RT MID1/3 PARASAGITTAL | 5x4 | Headache/vomiting | **II** | **1** | GRADE 2 | 1 | Improved | **4** |
| 38 | MUTHUMEENA | 37/F | 69789 | 03/11/12 | LT.CP ANGLE | 4x4 | Headache/vomiting | **II** | **0** | GRADE 1 | 1 | Improved | **4** |
| 39 | JOTHI | 35/F | 80214 | 05/11/12 | LT. TENTORIAL | 5x4 | Headache/Loss of vision | **III** | **1** | GRADE 1 | 1 | pseudomeningocele/CSF leak | **1** |
| 40 | HANTHI MURUGAN | 30/F | 89115 | 16/11/12 | RT FRONTAL CONVEXITY | 4x4 | Seizures | **II** | **2** | GRADE 1 | 1 | Improved | **4** |
| 41 | PONMOZHI | 40/F | 97664 | 27/12/12 | RT.CLINOIDAL | 3x3 | Headache/Blurred vision | **II** | **-1** | GRADE 3 | 1 | Improved | **5** |
| 42 | GANESAN | 55/M | 96810 | 24/12/12 | LT.MID 3RD PARASAGITTAL | 5x4 | Headache/vomiting | **II** | **1** | GRADE 2 | 1 | Improved | **4** |
| 43 | LAKSHMI | 48/F | 00597 | 03/01/13 | INTRAVENTRICULAR | 5x5 | Headache/vomiting | **II** | **1** | GRADE 3 | 1 | DVT | **1** |
| 44 | RAJALAKSHMI | 45/F | 4500 | 10/01/13 | OLFACTORY GROOVE | 3x3 | nosmia/behavioural chang | **I** | **1** | GRADE 2 | 1 | Improved | **5** |
| 45 | MEENA | 35/F | 5436 | 22/01/13 | FALX MENINGIOMA | 11x7 | Seizures/Rt.hemiparesis | **II** | **2** | GRADE 2 | 1 | Aphasia/Rt.hemiplegia | **4** |
| 46 | NAGAMMAL | 45/F | 7737 | 19/01/13 | LT.PARASAGITTAL | 5x5 | Seizures/rt.hemiparesis | **II** | **2** | GRADE 2 | 1 | hemiparesis | **3** |

# PLAGIARISM-DIGITAL RECEIPT

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